

What is claimed is

1        1. A method of test generation for testing computer  
2 software, comprising the steps of:

3        modeling a software application as a finite state ma-  
4 chine to define a behavioral model;

5        associating said behavioral model with a focus, said  
6 focus having a reference to said behavioral model, and  
7 having at least one directive; and

8        generating a test program according to state transi-  
9 tions of said behavioral model and said directive of said  
10 focus.

1        2. The method according to claim 1, wherein said di-  
2 rective comprises a model independent directive.

1        3. The method according to claim 1, wherein said di-  
2 rective comprises a model dependent directive, and a cov-  
3 erage variable of said behavioral model is tagged by a  
4 tag of said model dependent directive, said coverage  
5 variable having allowable values.

1        4. The method according to claim 3, wherein said di-  
2 rective further comprises a model independent directive.

1        5. The method according to claim 3, wherein said test  
2 program references said coverage variable, and said step

3 of generating is performed until said coverage variable  
4 has assumed each of said allowable values.

1 6. The method according to claim 5, wherein said cov-  
2 erage variable comprises a plurality of coverage vari-  
3 ables, and said step of generating is performed until a  
4 cross product of said coverage variables has assumed all  
5 possible values thereof.

1 7. The method according to claim 5, wherein said cov-  
2 erage variable comprises a plurality of coverage vari-  
3 ables, and said step of generating is performed until an  
4 orthogonal array of said coverage variables has assumed  
5 all possible values thereof.

1 8. The method according to claim 3, wherein said  
2 model dependent directive comprises a plurality of model  
3 dependent directives, and said coverage variable is  
4 tagged by a plurality of tags of said model dependent di-  
5 rectives.

1 9. The method according to claim 3, wherein said tag  
2 is a number-of-tests-per-value tag.

1 10. The method according to claim 3, wherein said  
2 model dependent directive is a mask-value directive.

1 11. The method according to claim 1, wherein said di-  
2 rective comprises a plurality of directives that are com-  
3 bined to define a directive expression, wherein said step  
4 of generating is performed until said directive expres-  
5 sion has a predetermined value.

1 12. The method according to claim 1, wherein said  
2 step of modeling is performed by retrieving said behav-  
3 ioral model from a model archive.

1 13. The method according to claim 1, wherein said  
2 step of associating is performed by retrieving said focus  
3 from a focus archive.

1 14. The method according to claim 13, further com-  
2 prising the steps of comparing state variables of foci of  
3 said focus archive with state variables of said behav-  
4 ioral model; and

5 responsive to comparisons resulting from said step of  
6 comparing revising selected ones of said foci.

1 15. A computer software product, comprising a com-  
2 puter-readable medium in which computer program instruc-  
3 tions are stored, which instructions, when read by a com-  
4 puter, cause the computer to execute a method of test  
5 generation for testing computer software, the method com-  
6 prising the steps of:

7        accepting as a first input a behavioral model of a  
8        software application, wherein said behavioral model com-  
9        prises a finite state machine;

10       accepting as a second input a focus having a refer-  
11       ence to said behavioral model, and having at least one  
12       directive;

13       associating said behavioral model with said focus;  
14       and

15       generating a test program according to state transi-  
16       tions of said behavioral model and said directive of said  
17       focus.

1       16. The computer software product according to  
2       claim 15, wherein said directive comprises a model inde-  
3       pendent directive.

1       17. The computer software product according to claim  
2       15, wherein said directive comprises a model dependent  
3       directive, and a coverage variable of said behavioral  
4       model is tagged by a tag of said model dependent direc-  
5       tive, said coverage variable having allowable values.

1       18. The computer software product according to  
2       claim 17, wherein said directive further comprises a  
3       model independent directive.

1       19. The computer software product according to  
2       claim 17, wherein said test program references said cov-

3 erage variable, and said step of generating is performed  
4 until said coverage variable has assumed each of said al-  
5 lowable values.

1 20. The computer software product according to  
2 claim 19, wherein said coverage variable comprises a plu-  
3 rality of coverage variables, and said step of generating  
4 is performed until a cross product of said coverage vari-  
5 ables has assumed all possible values thereof.

1 21. The computer software product according to  
2 claim 19, wherein said coverage variable comprises a plu-  
3 rality of coverage variables, and said step of generating  
4 is performed until an orthogonal array of said coverage  
5 variables has assumed all possible values thereof.

1 22. The computer software product according to  
2 claim 17, wherein said model dependent directive com-  
3 prises a plurality of model dependent directives, and  
4 said coverage variable is tagged by a plurality of tags  
5 of said model dependent directives.

1 23. The computer software product according to  
2 claim 17, wherein said tag is a number-of-tests-per-value  
3 tag.

1        24. The computer software product according to  
2 claim 17, wherein said model dependent directive is a  
3 mask-value directive.

1        25. The computer software product according to  
2 claim 15, wherein said directive comprises a plurality of  
3 directives that are combined to define a directive ex-  
4 pression, wherein said step of generating is performed  
5 until said directive expression has a predetermined  
6 value.

1        26. The computer software product according to  
2 claim 15, wherein said step of modeling is performed by  
3 retrieving said behavioral model from a model archive.

1        27. The computer software product according to  
2 claim 15, wherein said step of associating is performed  
3 by retrieving said focus from a focus archive.

1        28. The computer software product according to  
2 claim 27, further comprising the steps of comparing state  
3 variables of foci of said focus archive with state vari-  
4 ables of said behavioral model; and  
5 responsive to comparisons resulting from said step of  
6 comparing revising selected ones of said foci.

1        29. A method of test generation for testing computer  
2 software, comprising the steps of:

3 modeling a software application as a finite state ma-  
4 chine to define a behavioral model;

5 associating said behavioral model with a focus, said  
6 focus having a reference to said behavioral model, and  
7 having at least one directive;

8 deriving an abstract test suite from said behavioral  
9 model and said focus, wherein said abstract test suite  
10 complies with a test constraint that is encoded in said  
11 focus;

12 executing said abstract test suite in an execution  
13 engine.

1 30. The method according to claim 29, wherein said  
2 step of executing said abstract test suite comprises the  
3 step of generating a test script from said abstract test  
4 suite; wherein said test script is executed in said exe-  
5 cution engine.

1 31. The method according to claim 29, wherein said  
2 step of producing said abstract test suite is performed  
3 with a testing interface.

1 32. The method according to claim 31, wherein said  
2 testing interface comprises an abstract-to-concrete  
3 translation table.

1 33. The method according to claim 29, wherein said  
2 testing interface comprises a test driver, having an op-  
3 erator interface, and further comprising the step of:

4 varying parameters of said test driver via said op-  
5 erator interface in accordance with requirements of said  
6 software application.

1 34. The method according to claim 29, wherein said  
2 directive comprises a model independent directive.

1 35. The method according to claim 38 wherein said  
2 coverage variable comprises a plurality of coverage vari-  
3 ables, and said step of generating is performed until a  
4 cross product of said coverage variables has assumed all  
5 possible values thereof.

1 36. The method according to claim 38, wherein said  
2 coverage variable comprises a plurality of coverage vari-  
3 ables, and said step of generating is performed until an  
4 orthogonal array of said coverage variables has assumed  
5 all possible values thereof.

1 37. The method according to claim 29, wherein said  
2 directive comprises a model dependent directive, and a  
3 coverage variable of said behavioral model is tagged by a  
4 tag of said model dependent directive, said coverage  
5 variable having allowable values.

1 38. The method according to claim 37, wherein said  
2 abstract test suite references said coverage variable,  
3 and said step of generating is performed until said cov-  
4 erage variable has assumed each of said allowable values.

1 39. The method according to claim 37, wherein said  
2 directive further comprises a model independent direc-  
3 tive.

1 40. The method according to claim 37, wherein said  
2 model dependent directive comprises a plurality of model  
3 dependent directives, and said coverage variable is  
4 tagged by a plurality of tags of said model dependent di-  
5 rectives.

1 41. The method according to claim 37, wherein said  
2 tag is a number-of-tests-per-value tag.

1 42. The method according to claim 37, wherein said  
2 model dependent directive is a mask-value directive.

1 43. The method according to claim 29, wherein said  
2 directive comprises a plurality of directives that are  
3 combined to define a directive expression, wherein said  
4 step of generating is performed until said directive ex-  
5 pression has a predetermined value.

1 44. The method according to claim 29, wherein said  
2 step of modeling is performed by retrieving said behav-  
3 ioral model from a model archive.

1 45. The method according to claim 29, wherein said  
2 step of associating is performed by retrieving said focus  
3 from a focus archive.

1 46. The method according to claim 29, further com-  
2 prising the steps of comparing state variables of foci of  
3 said focus archive with state variables of said behav-  
4 ioral model; and

5 responsive to comparisons resulting from said step of  
6 comparing revising selected ones of said foci.

1 47. A computer software product for testing computer  
2 software, comprising a computer-readable medium in which  
3 computer program instructions are stored, which instruc-  
4 tions, when read by a computer, cause the computer to  
5 perform the steps of:

6 associating a behavioral model of a software applica-  
7 tion with a focus, said focus having a reference to said  
8 behavioral model, and having at least one directive,  
9 wherein said behavioral model models a finite state ma-  
10 chine;

11 deriving an abstract test suite from said behavioral  
12 model and said focus, wherein said abstract test suite

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13 complies with a test constraint that is encoded in said  
14 focus;  
15 executing said abstract test suite in an execution  
16 engine.

1 48. The computer software product according to  
2 claim 47, wherein said step of executing said abstract  
3 test suite comprises the step of generating a test script  
4 from said abstract test suite; wherein said test script  
5 is executed in said execution engine.

1 49. The computer software product according to  
2 claim 47, wherein said step of producing said abstract  
3 test suite is performed with a testing interface.

1 50. The computer software product according to  
2 claim 49, wherein said testing interface comprises an ab-  
3 stract-to-concrete translation table.

1 51. The computer software product according to  
2 claim 49, wherein said testing interface comprises a test  
3 driver, having an operator interface, and further com-  
4 prising the step of:

5 varying parameters of said test driver via said op-  
6 erator interface in accordance with requirements of said  
7 software application.

1        52. The computer software product according to  
2 claim 47, wherein said directive comprises a model inde-  
3 pendent directive.

1        53. The computer software product according to  
2 claim 29, wherein said directive comprises a model de-  
3 pendent directive, and a coverage variable of said behav-  
4 ioral model is tagged by a tag of said model dependent  
5 directive, said coverage variable having allowable val-  
6 ues.

1        54. The computer software product according to  
2 claim 53 wherein said coverage variable comprises a plu-  
3 rality of coverage variables, and said step of generating  
4 is performed until a cross product of said coverage vari-  
5 ables has assumed all possible values thereof.

1        55. The computer software product according to  
2 claim 53, wherein said coverage variable comprises a plu-  
3 rality of coverage variables, and said step of generating  
4 is performed until an orthogonal array of said coverage  
5 variables has assumed all possible values thereof.

1        56. The computer software product according to  
2 claim 53, wherein said abstract test suite references  
3 said coverage variable, and said step of generating is  
4 performed until said coverage variable has assumed each  
5 of said allowable values.

1 57. The computer software product according to  
2 claim 53, wherein said directive further comprises a  
3 model independent directive.

1 58. The computer software product according to  
2 claim 53, wherein said model dependent directive com-  
3 prises a plurality of model dependent directives, and  
4 said coverage variable is tagged by a plurality of tags  
5 of said model dependent directives.

1 59. The computer software product according to  
2 claim 37, wherein said tag is a number-of-tests-per-value  
3 tag.

1 60. The computer software product according to  
2 claim 37, wherein said model dependent directive is a  
3 mask-value directive.

1 61. The computer software product according to  
2 claim 47, wherein said directive comprises a plurality of  
3 directives that are combined to define a directive ex-  
4 pression, wherein said step of generating is performed  
5 until said directive expression has a predetermined  
6 value.

1        62. The computer software product according to  
2 claim 47, wherein said step of modeling is performed by  
3 retrieving said behavioral model from a model archive.

1        63. The computer software product according to  
2 claim 47, wherein said step of associating is performed  
3 by retrieving said focus from a focus archive.

1        64. The computer software product according to  
2 claim 63, further comprising the steps of comparing state  
3 variables of foci of said focus archive with state vari-  
4 ables of said behavioral model; and

5        responsive to comparisons resulting from said step of  
6 comparing revising selected ones of said foci.

1        65. A computer system for testing computer software,  
2 comprising:

3        a user interface for creating a behavioral model of a  
4 software application, said behavioral model representing  
5 a finite state machine, wherein said user interface cre-  
6 ates a focus, said focus having a reference to said be-  
7 havioral model, and having at least one directive;

8        a compiler, for converting said behavioral model into  
9 an intermediate encoding thereof;

10       a test generator, accepting said intermediate encod-  
11 ing and said focus as input, and producing an abstract  
12 test suite;

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13 an execution engine for executing a test program of  
14 said abstract test suite.

1 66. The system according to claim 65, wherein said  
2 execution engine produces a suite execution trace.

1 67. The system according to claim 66, further com-  
2 prising an analyzer which reads said suite execution  
3 trace, wherein said execution engine accepts an output of  
4 said analyzer.

1 68. The system according to claim 65, further com-  
2 prising a visualizer for visualizing an output of said  
3 execution engine.

1 69. The system according to claim 65, wherein said  
2 execution engine further receives input from an applica-  
3 tion model interface that is created by said user inter-  
4 face.

1 70. The system according to claim 65, wherein said  
2 directive comprises a model independent directive.

1 71. The system according to claim 65, wherein said  
2 directive comprises a model dependent directive, and a  
3 coverage variable of said behavioral model is tagged by a  
4 tag of said model dependent directive, said coverage  
5 variable having allowable values.

1       72. The system according to claim 71, wherein said  
2       directive further comprises a model independent direc-  
3       tive.

1       73. The system according to claim 71, wherein said  
2       test program references said coverage variable, and said  
3       test generator operates until said coverage variable has  
4       assumed each of said allowable values.

1       74. The system according to claim 73, wherein said  
2       coverage variable comprises a plurality of coverage vari-  
3       ables, and said execution engine executes until a cross  
4       product of said coverage variables has assumed all possi-  
5       ble values thereof.

1       75. The system according to claim 73, wherein said  
2       coverage variable comprises a plurality of coverage vari-  
3       ables, and said execution engine executes until an or-  
4       thogonal array of said coverage variables has assumed all  
5       possible values thereof.

1       76. The system according to claim 71, wherein said  
2       model dependent directive comprises a plurality of model  
3       dependent directives, and said coverage variable is  
4       tagged by a plurality of tags of said model dependent di-  
5       rectives.

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1 77. The system according to claim 71, wherein said  
2 tag is a number-of-tests-per-value tag.

1 78. The system according to claim 71, wherein said  
2 model dependent directive is a mask-value directive.

1 79. The system according to claim 65, wherein said  
2 directive comprises a plurality of directives that are  
3 combined to define a directive expression, wherein said  
4 execution engine executes until said directive expression  
5 has a predetermined value.

1 80. The system according to claim 65, further com-  
2 prising a model archive that is accessed by said user in-  
3 terface.

1 81. The system according to claim 65, further com-  
2 prising a focus archive that is accessed by said user in-  
3 terface.

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